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DEVELOPMENT OF IN-SITU MANUFACTURING FOR STRUCTURAL ELEMENTS BY COMBINING ISRU AND SPACE DEBRIS

Abstract

This report is led by the SEEDS XVI team and aims to design and develop essential technologies for a human Mars habitat, considering future perspectives towards the year 2040. The project involves an international collaborative effort involving students from ISAE-SUPAERO, Polytechnic University of Turin, and the University of Leicester, adopting a systems engineering approach.

In the context of space exploration, the traditional approach involves transporting prefabricated structural elements from Earth, incurring significant costs and logistical challenges. The project suggests an alternative method by harnessing local resources through ISRU and repurposing space debris for the on-site manufacturing of structural components. This approach aligns with the broader goal of achieving sustainability and self-sufficiency in future human habitats beyond Earth. Additive manufacturing emerges as a pivotal technology for in-situ manufacturing, addressing challenges related to spares for deep spaceflight. The report delves into the versatility of additive manufacturing processes, considering the diverse range of materials and technologies suitable for crafting structural elements by carrying out detailed trade off studies.

The potential integration of space debris, considered a valuable resource, aligns with the circular systems approach, contributing to waste reduction in space missions. The report explores the engineering challenges associated with processing space debris into usable materials and incorporating them into manufacturing processes for structural components. Ongoing developments in In-Situ/Space Manufacturing, such as the ISS Portable On-Board Printer (POP) and In-Orbit Manufacturing (IOM), serve as benchmarks for the project's goals. Testing the feasibility of in-situ manufacturing under simulated space conditions, especially considering the unique challenges of Mars, remains a key aspect of the research.

As the project envisions a future where human habitats are constructed using local resources and space debris, it is not only addressing the challenges of deep space exploration but also contributes to the broader vision of sustainable human presence beyond Earth. The findings of this collaborative effort provide insights into the transformative potential of in-situ manufacturing, laying the groundwork for the development of resilient and self-sufficient habitats in the cosmos.

The project harnesses the combined knowledge of faculty members and mentors from ISAE-SUPAERO, Politecnico di Torino, and the University of Leicester. The variety of viewpoints and collaborative achievements stemming from this partnership enhance the project, nurturing an environment of teamwork that propels advancements. Ultimately, this systems engineering endeavour signifies a significant stride towards establishing a viable human settlement on Mars.